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Team performance as a function of task structure and work structure

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Team performance as a function of

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Introduction

Although individuals in many work situations are members of a team, the psychological literature relevant to team performance lacks any semblance of order or coherence. There are several problems which account for this: differences between dyads and larger groups (Weick & Penner, 1966), use of groups to study tasks rather than tasks to study groups (Hackman, 1968), and failure to characterize adequately groups which are teams (Klaus & Glaser, 1970). Following a brief review of these problems, two models of group and team performance are presented. The group performance model is not completely relevant to the performance of teams, but it does provide a framework for establishing models of team performance. The team performance model is presented in greater detail, and its predictive power is evaluated in a three-member team situation.

Social psychologists in their concern with the dyad as the basic unit for studying group processes, have neglected an important and equally basic unit, the triad (Weick & Penner, 1966). Moreover, most processes that occur in larger groups can be found in triads but not necessarily in dyads. In an early theoretical exposition Simmel (1902) contrasted dyads with triads, noting that the third party affords an audience for the other two; each person may be directly and/or indirectly related to each of the others; also coalescence and cleavages of subgroups are possible (cf., Caplow, 1959; Kelley & Arrowood, 1960). In comparison to dyads, triads make available additional sources of reinforcement: joint cost-cutting, joint consumption, mutual facilitation of enjoyment, emergent products, and sequential patterns of interdependence (Thibaut & Kelley, 1959). O'Dell (1968) studied the interaction of group sizes 2-5, using Bales' (1951) system. His findings support the Bales and Borgatta (1955) conclusion that dyadic interaction is uniquely different from groups of larger size.

The findings relating performance to group size are mixed. Thomas and Fink (1963) reviewed the literature and concluded both quality of performance and group productivity were positively related to group size under some conditions, whereas under no conditions were smaller groups superior. In contrast, speed of performance showed no difference or favored smaller groups.

Considering examples of research which used two- and/or three-man groups does not lead to different conclusions. Ziller (1957) found a positive relationship between group size (2-6) and quality of judgments, but Lorge and Solomon (1959, 1960) discovered no relationship between group size (2-7) and the proportion of groups which solved the Tartaglia problem. With regard to productivity, Gibb (1951) found a negatively accelerated curve. He compared individuals and group sizes (2, 3, 6, 12, 24, 48, and 96), and found that with increments in group size there were progressively smaller increases in the number of ideas produced. However, Kidd (1958) found no differences in productivity (unscrambling sentences) between groups of two, four, and six.

Speed of performance was not significantly different between two-man versus three-man groups (Perlmutter, 1953) nor between two-man versus four-man groups (Taylor & Faust, 1952). Moreover, Morrissette, Switzer, and Crannel (1965) compared four-man to five-man groups and found no difference in solution time or number of errors. In contrast, Morrissette (1966) compared three-man groups to the four-man groups and observed that the three-man groups were faster.

In sum, it appears that triadic processes are more representative of larger groups than dyadic processes (Weick & Penner, 1966), and that performance of triads is more similar to larger groups (Thomas & Fink, 1963). Therefore, to the extent that findings on groups generalize to teams, it would be more appropriate to study three-man rather than two-man teams. This should allow greater generalizability of the findings to larger teams.

Other researchers have emphasized the importance of the task as a variable influencing group processes. Several reviews of small groups research indicate that certain areas (e.g., leadership) have received considerable attention and certain methodologies (e.g., sociometric measurement) have been developed to a high degree of sophistication, while others have not (Hackman, 1968). McGrath and Altman (1966) in their review point out that the study of environmental influences on group performance has not been given sufficient attention in either the methodological or substantive domain. The problem is that small groups researchers have used tasks to study groups but have not used groups to study tasks (Hackman, 1968). An allied problem is that the specific tasks devised for specific studies are generally not comparable across studies (Swinth & Tuggle, 1971). This is an important consideration, since research has shown that task characteristics control the major portion of the variance in performance (Kent & McGrath, 1969).

Differences between small groups and teams are a problem in generalizing the results of most studies on group performance to that of teams (Glanzer, 1962). Teams are conceptualized as structured groups and are characterized by goal-orientation and a structured environment (cf., Dickinson, 1967; Naylor & Briggs, 1965). Teams have definite goals, are generally rigid in organizational structure and communication network, have well defined positions or assignments, and depend on cooperative or coordinated participation (Klaus & Glaser, 1970). In contrast, small groups generally have an indefinite or manipulable structure, organization, and communication network. Furthermore, small groups have assumed rather than designated positions or assignments, depend on individual contributions, and may function even when some members are not contributing (e.g., Hare & Bales, 1963). Most research has been on unstructured groups (i.e., the groups had no clear pattern of assigned roles) carrying out a relatively unstructured task, such as problem solving (Hare, 1953; Lewin, 1958; Schachter, 1951).

Models of Group and Team Performance

There are several essential characteristics for a model of team performance. Obviously the model must address itself to team rather than small group performance. It should pay explicit attention to the task, and also specify the processes of attaining the team product. It was once thought that composite performance would be equal to the sum of the individual's performances; however, composite performance is usually less than the sum of individual's performances (Taylor & Faust, 1952) but may be greater under certain circumstances, such as when coordination of resources is required (Olson & Davis, 1964; Steiner, 1966). Early philosophers and psychologists were of the opinion that the interaction of individuals and tasks determined the individual's performance, i.e., prior to Triplett (1898). However, evidence on small group performance has shown that individual performance is affected by other persons as well as the individual-task interaction

(Zajonc, 1966). Recently a framework for analyzing the effects of tasks on individual and group behavior (Hackman, 1969) and a model of team performance (Naylor & Dickinson, 1969) have been presented.

Hackman Model

Tasks have been equated with situations by several investigators (Hackman, 1969; Hare, 1962; McGrath & Altman, 1966). For example, Hare (1962) states, "the definition of the task is the definition of the situation, and differences in behavior which appear between situations are the most general indication of differences in tasks [pp. 248-249]." Two similar definitions of group tasks are presented by McGrath and Altman (1966, p. 75):

> What is "task" and what is "group" tend to shade together in many specific instances (e.g., actions toward organizing a division of labor in the group). It is probably useful to conceptualize all groups as having tasks--hence equating tasks with "goals". ... [Any task] can also be defined to include all factors impinging on the group and its members whose origins are not properly attributable to members or to the group. This kind of definition tends to equate task and environment effects, as the total situation.

Hackman (1969) is in substantial agreement with these positions and indicates it is regretable that little is known about how situations determine behavior. He proposes that if tasks are equated with situations, the development of a theory of task effects must be included in a theory of situational effects. Nonetheless, Hackman (1969) takes the more modest approach of proposing a framework only for analyzing the effects of tasks. Unfortunately he does not distinguish between individuals, groups, and teams (e.g., he uses performer and performers interchangeably).

Hackman's framework describes some effects attributable to tasks (and task characteristics) and identifies loci in the performance process where personal factors have important interactions with task-based factors. He emphasizes the cognitive redefinition of the objective task inputs by the performer(s). Four personal factors which affect this process of redefinition are: understanding of task, acceptance of task, idiosyncratic needs and values, and previous experience with similar tasks. After redefinition, the performer formulates some hypotheses about how he should perform which may be relevant to the strategy of performance or the actual behavior. When trial behavior is elicited and feedback obtained, the trial behavior is evaluated by the person and/or the system. If the evaluation is negative, the task performance process is recycled back to the hypothesis stage; if the evaluation is positive, the trial outcome becomes the final outcome.

Hackman (1969) expounds his model in reference to two descriptions of how tasks and task factors influence behavior. These are task-qua-task, which is an analysis of and theorizing about actual task materials presented to performers, and task as a behavioral requirement, which is a description of how cognitive process-outcome links mediate between behavior and the attainment of outcomes (Hackman, 1969). Although the latter approach embodies his theory, Hackman (1969, p. 110) admits that the task-qua-task approach has the advantage of precise operational specification; in addition, the task properties are measurable independently of the behavior to which they are expected to be related. But, he questions whether it is feasible to describe tasks in task-qua-task terms. Fortunately, this is a question which can be answered empirically.

In summary, Hackman's (1969) model has several limitations in dealing with team performance. First, Hackman admits that his framework considers only task effects and does not encompass situational effects. Thus variables such as group composition, member interactions, division of labor, etc., which may influence team performance singly or in interaction with task factors are ignored. Second, there is question as to whether the model is applicable to individual, group, or team performance. Third, the model takes a decidedly cognitive orientation as to how tasks and task factors influence behavior. Given the present state of knowledge about team performance, it would be more efficient to pursue a behavioral orientation. This approach has the advantages of definite operationalizations and the property of independent measurement.

Dickinson-Naylor Model

Recently Dickinson and Naylor have presented a model of team performance (Dickinson & Naylor, 1967; Naylor & Dickinson, 1969) which attends to situational effects and task characteristics. Their model states that performance is a function of task structure, work structure, and communication structure. Task structure is viewed as the demand characteristics of the delineable subtasks or components which may be performed by team members. Specifically, the task structure dimension is a function of component complexity, component organization, and component redundancy. They define the complexity of a component in terms of its information-processing and/or memory storage-demand requirements. Organization of components is defined by the demands imposed by the total task due to interrelationships between or among components. Finally, component redundancy is defined by the degree of overlap or duplication in information processing among the subtasks or components.

Dickinson and Naylor have described the dimension of work structure as the manner in which subtasks or components are distributed among or assigned to the team members and the manner in which team members are required to interact. Thus work structure involves the following: the determination of the task operations, the sequence of operations, and the channels of interaction among team members.

The Dickinson-Naylor model contends that communication structure depends upon the task structure and work structure dimensions. Once the task and work structure dimensions are determined, team members themselves will develop a particular communication structure within the limits imposed by these dimensions.

Example of team performance. A description of a typical operation performed by a work team will help to clarify the concepts of the model. Consider a rotary drilling rig crew. The crew is composed of four members: driller, derrick man, and two roughnecks. The objective of the team is to drill a hole (oil or gas well) of specified diameter and depth as fast as possible. The work is quite repetitive, since the same operations are performed many times for each hole.

A common operation is making a connection. In order to illustrate the concepts of the model the task components performed by each team member in the connection operation must be defined. The derrick man performs one component, starting and stopping the pump. The driller has four manipulative components: he controls the drum for raising the kelly (a square piece of pipe which is rotated for drilling) and drill pipe, the brake for lowering the kelly and drill pipe, the table for turning the kelly, and the reel for pulling a chain and wrench. The roughnecks perform three components: they fasten, set, and unfasten the wrenches; they slip wedges into and pull wedges out of the rotary table to hold the drill pipe; and they wrap and hold the chain. These task components have been defined without attention to temporal sequence, but they must be performed in relation to each other.

This connection operation illustrates the aspects of the task structure dimension. Component complexity is greater for the driller than the other three team members because the information-processing and memory storage demand requirements of his components are greatest. The derrick man needs only to watch the kelly to determine when the pump should be running. Roughnecks merely respond to the stimuli provided by the driller; i.e., they set the wrenches, and after the driller pulls them, they release them. But the driller must appropriately manipulate the drum, brake, reel, and rotary table.

The component organization aspect is illustrated by the interrelationships among the components. As with task components, information processing demands are greatest for the driller. He must coordinate his task components as well as those of the other team members with his own. For example, after the driller has raised the kelly, he must allow the roughnecks to slip the wedges and insure the wedges hold before doing his next component. The component redundancy aspect of task structure is most noticeable in the roughnecks' performance. Their actions constantly overlap with each other. Most of their individual behavior involves: helping each other, e.g., slip or pull the wedges; preparing for the next component, e.g., wrap the chain or fasten a wrench; or completing a component while another is preparing.

The connection operation also demonstrates aspects of work structure. Task components are distributed to team members according to physical location of the member and the component. Since the sequence of component performance is predetermined (e.g., the driller must raise the kelly before the roughnecks can pull the wedges) the components are assigned to the most readily available team member(s). Thus most task components are uniquely distributed; each subtask is assigned to one team member. Exceptions to the unique distribution are a few of the roughnecks' subtasks which require two men. Work interaction is characterized by sequential dependencies. One team member must have his component prepared and be able to perform it as soon as the preceding component has been performed.

Little communication structure is necessary for the performance of a rotary drilling rig crew. Each member knows from previous experience what components the other team members will do and when they will do them. It is a matter of timing, supplemented by nonverbal cues; thus the work structure and task structure place limitations on communication structure. Verbal communication is unnecessary because each of the team members has his own subtasks to perform. Although these subtasks are interrelated, they have been practiced many times thereby minimizing the need for communication. The only occasion which evokes verbal communication is when one team member has been replaced by a new, unskilled man.

Review of research relevant to task structure. As mentioned above, in the Dickinson-Naylor model task structure is defined as a function of the individual and joint demand characteristics of the separate task components: component complexity, component organization, and component redundancy. These specifications allow predictions of the effects of component complexity, organization, and redundancy on team performance. Increasing component complexity or component organization decreases team performance, whereas increasing component redundancy increases team performance.

Evidence for the effect of task complexity on performance is presented in a number of studies. Generally, it has been shown that higher performance or less error is associated with lower task complexity (Brehmer, 1972; Briggs & Naylor, 1962; Naylor & Briggs, 1963). Increasing cue predictability in information processing studies has been found to decrease task complexity, resulting in a decrease of task demands. In these studies performance was enhanced by increases in cue validity or predictability (Brehmer & Lindberg, 1970; Dudycha & Naylor, 1966b; Naylor & Clark, 1968; Naylor & Schenck, 1968; Schenck & Naylor, 1965). Although the above findings agree with the model's prediction, they provide only qualified support because generalizing the results from individuals to teams is tenuous. However, Shaw (1954) found large differences in solution time between teams solving problems of different complexities. Also, there are two other studies on teams which support the prediction (Dickinson, 1967; Johnston & Briggs, 1968).

A study of the effect of component organization on team performance was conducted by Naylor and Dickinson (1969). They observed that task organization was inversely related to team performance. This study also examined the effect of task structure (task complexity combined with task organization), finding team performance directly related to task structure. These results support the model's prediction that as task demands are decreased, performance is increased. Other results indicate that a task characterized by complexity allows greater team performance than one characterized by organization (Dickinson, 1969b). This implies greater information processing demands for task organization than for task complexity.

Several investigations have shown the effect of component redundancy or overlap on an individual's performance. Dudycha and Naylor (1966a) found that individuals rated job desirabilities more consistently when the components were redundant. This was shown by analyses of both individuals' regression equations and policy comparisons. Slovic (1966) uniquely manipulated the redundancy of two cues embedded in a nine-cue profile. The pair of cues had previously been shown to account for most of the variance in individuals' predictions. When the cues were highly redundant both cues were used. However, when there was low redundancy between the cues only one of the pair was used in conjunction with some of the other previously ignored cues; the remaining cue of the pair was not considered, and performance was less consistent and accurate. Other investigations have found similar results (Howell, Gettys, Martin, Nawrocki, & Johnston, 1970; Naylor & Schenck, 1968). Since these results come from research on individuals, they provide only tentative support for the model's prediction that the presence of component redundancy increases performance.

Review of research relevant to work structure. In the Dickinson-Naylor model the aspects of work structure (task component distribution and work interaction) influence team performance. When task components are distributed maximally, performance is decreased due to dispersion demands, i.e., less of the total task is available to any given team member. Conversely, minimizing task component distribution enhances team performance. Demands due to the work interaction aspect may increase or decrease team performance. Work interaction facilitates team performance when members are dependent on others to execute their subtasks, but retards team performance when members are independent.

Several studies (Dickinson, 1969a, 1969b; Dickinson & Naylor, 1967) present evidence for the influence of different task-component distributions on member and team performance. In the Dickinson and Naylor (1967) study, team members in one work structure condition observed a single cue or component; in another condition both components were present but the team member was instructed to use just one or the other component; in the remaining condition both components were present and the team members were instructed to use both. Performance was lower in the single component condition than in either of the other work structure conditions. This effect appears due to the amount of total task information that is available to the team members (Dickinson, 1969a, 1969b).

There is ample evidence that team performance is a function of the extent to which team members are allowed to interact with each other (Briggs & Naylor, 1965; Johnston, 1966; Johnston & Briggs, 1968; Naylor & Briggs, 1965). These investigations found that unnecessary work interaction is detrimental to team performance in tasks of various complexities; work interaction added irrelevant demands on the team members. In particular, when members were required or allowed to communicate, and communication was irrelevant to task execution, performance was depressed. Another study has shown that team members dependent on other members for information or input have to interact in order to complete their own subtask (Dickinson, 1969a).

Review of research relevant to the interplay of task structure and work structure. As indicated in the previous section, the task component distribution and work interaction aspects of work structure focus on task components. The influence that these aspects of work structure have on team performance depends on the demand requirements of the components. This idea is similar to Roby and Lanzetta's (1958) notion of critical demands where properties of task events interact with group events to determine group performance. For example, when organized or interrelated task components are distributed among several team members, performance is facilitated by increased work interaction. Conversely, if all of the organized components are distributed to the same team member, this facilitative effect is not present. This is tantamount to an interaction between task structure and work structure. Two studies have investigated this prediction of the model (Dickinson, 1969a, 1969b).

One form of this interaction is between task component distribution and task structure. Team performance in a task characterized by organized components should improve as more of the total task information is made available; however, task component distribution should be less important when the task is characterized by complexity. Dickinson (1969b) investigated this prediction and found strong support for an interaction between task structure and task component distribution. This interaction was due to differential performance in the task component distribution conditions of the task characterized by organization. Performance was least when components were maximally distributed, intermediate when moderately distributed, and greatest when components were minimally distributed. There were no significant differences among the task component distribution conditions of the task characterized by complexity.

Another form of the task structure and work structure interaction is between work interaction and task component distribution. In a task characterized by organization (interrelationships between components), unrestricted work interaction is predicted to enhance team performance when the task components are distributed; whereas, work interaction has less influence when all team members have all components. In one study the interaction was nonsignificant for team performance, but was significant for member's performance in a task characterized by organization (Dickinson, 1969a). Work interaction was manipulated by restrictive (revisive and directive) or unrestrictive (cooperative) instructions. Task-component distribution was manipulated by the number of components available: one-component, partial two-component, and two-component. The interaction appeared due to the relative increase in member performance for the partial two-component cooperative condition. Work interaction conditions were not significantly different in the two-component and one-component profiles. Thus, unrestricted communication enhances member performance when an intermediate amount of the total task information is available.

Review of research relevant to communication structure. The Dickinson-Naylor Model predicts that particular communication structures will be developed as a function of particular work and task structures. Work and task structure limit the range of communication structures which a team will develop; when either work or task structure changes the possibilities of communication structure change. This point of view is similar to that of Faucheux and MacKenzie (1966). These authors studied the organization of communication interaction, and concluded that communication structure is an intervening variable between task and behavior. Other evidence is provided by Swinth and Tuggle (1971) in a study of interacting problem-solving teams performing a task characterized by moderate organization. A majority of the four-member teams developed hierarchical rather than other communication structures, although these teams differed in the number of levels in their structures.

Statement of the Problem

It seems well established that task structure influences performance (Dickinson, 1967, 1969b; Naylor & Dickinson, 1969). The effect of work structure is less clear. Naylor and Dickinson (1969) found no effect of work structure on team performance, but work structure did affect the performance of team members. Dickinson (1969a) studied two aspects of the work structure dimension: task component distribution and work interaction. The task component distribution manipulation was significant but the work interaction was not. Another study by Dickinson (1969b) found significance for task component distribution but did not test work interaction.

The first purpose of this research was to evaluate the Dickinson-Naylor concepts for triadic teams. Perhaps work interaction lacks impact in the two-component, two-member team task. Larger team size should provide a better test of the work interaction aspect of the work structure dimension (Weick & Penner, 1966). Another purpose was to evaluate the influence of component redundancy which had not been examined previously in the context of team performance. The dependent variable was information processing, operationalized as team performance in a multiple-cue task. Hypotheses were drawn from the Dickinson and Naylor model concerning the effects of manipulations of the task structure and work structure dimensions. The following hypotheses pertain to the multiple-cue indices of team achievement and matching.

Hypothesis I

Task structure will interact with task component distribution for indices of team performance. Tasks characterized by organization will yield a profile with positive slope from two components to three components, while tasks characterized by redundancy and complexity will have zero slopes. This will result from relatively high performance in the redundancy conditions and relatively low performance in a two component, organization condition; while the other conditions will not be significantly different.

Task-structure demand characteristics are greatest when components are interrelated, especially if the interrelated components are distributed between or among team members. On the other hand, task demand characteristics are least when components overlap. Dickinson (1969b) predicted and confirmed an interaction between task structure and task component distribution on team performance indices. The interactions were due to progressively lower performance associated with greater task component distribution for tasks characterized by organization. Hypothesis I is in agreement with Dickinson but goes beyond his finding to include an evaluation of redundancy.

Hypothesis II

Task structure will interact with work interaction for the indices of team performance. The profiles for the tasks characterized by redundancy and complexity will have zero slopes from restricted (i.e., limited interaction) to unrestricted work interaction, but the tasks characterized by organization will have positive slope. This positive slope will result from relatively low performance in a restricted, organization condition.

Restricted work interaction increases information-processing demands for tasks characterized by organization. Extrapolating from research findings on individuals, component redundancy decreases task demands, but component organization increases task demands. Since the work interaction aspect of work structure moderates the influence of task structure, performance is expected to be reduced by the restricted manner of interaction when components are interrelated. Hypothesis II has not been previously tested, but there is evidence for some parts of it. For example, team performance is greater under a task characterized by complexity than under one characterized by organization (Dickinson, 1969b). However, the only test of differences among work interaction conditions was nonsignificant for both member and team performance (Dickinson, 1969a). Recall that Dickinson studied two-member teams, but the way in which interaction must occur would seem to be more important in larger teams.

<u>Hypothesis III</u>

Task-component distribution will interact with work interaction. Restricted work interaction will yield a profile with positive slope from two components to three components, while that of unrestricted work interaction will have zero slope. This will result from relatively low performance in a restricted, two-component condition while the two- and three-component, unrestricted and a three-component, restricted conditions will not yield significant differences in performance.

Work structure demand characteristics are increased when the components are interrelated and distributed among the team members. When members have less than the total team task, performance will decrease unless team members increase work interaction (Swinth & Tuggle, 1971). This interaction was found by Dickinson (1969a) for member performance but was not observed for teams.

Method

Subjects

Three hundred-sixty students from psychology courses at Iowa State University served as *Ss*. They formed 120 three-member teams which were randomly assigned to experimental conditions on the basis of the *Ss'* availability. All *Ss* received a minor academic inducement of two experimental credits for participation. To insure the *Ss'* motivation a prize of five dollars per member was awarded to the team with the highest achievement in each of the twelve conditions.

Task

The team task was the Multiple Cue Inference Task (Dickinson, 1967). In this task *Ss* read two or three two-digit cues (Xs), and they then make predictions (Y_s) as to the value of the criterion (Y_e). Utilization of the cues, criterion, and team predictions allows computation of two different least squares regression equations. Equation 1 represents the optimal prediction strategy a team could use.

$$Y'_e = a_e + b_{1e}X_1 + b_{2e}X_2 + b_{3e}X_3 + b_{4e}X_4 + b_{5e}X_1X_4 + b_{6e}X_2X_3 \qquad [1]$$

In other words, a team could maximize its performance by weighting the cues as in the optimal regression equation. Equation 2 represents the prediction strategy of the team.

$$Y'_s = a_s + b_{1s}X_1 + b_{2s}X_2 + b_{3s}X_3 + b_{4s}X_4 + b_{5s}X_1X_4 + b_{6s}X_2X_3 \quad [2]$$

It indicates the manner in which the team actually used the cues to make its prediction.

Computation of the intercept and cue weights of Equations 1 and 2 for trials allows estimation of predicted values for each trial. When this is done the team responses, the criterion, and their predicted values can be intercorrelated to obtain four indices, three of which are descriptive of performance. These indices are defined below.

$$R_e = Cor(Y_e, Y'_e) = \text{cue-criterion predictability} \quad [3]$$

$$r_a = Cor(Y_e, Y_s) = \text{achievement} \quad [4]$$

$$R_s = Cor(Y_s, Y'_s) = \text{consistency} \quad [5]$$

$$r_m = Cor(Y'_e, Y'_s) = \text{matching} \quad [6]$$

Equation 3, cue-criterion predictability, represents the degree to which criterion values (Y_e) can be optimally predicted using cues as predictors (Y'_e). Three indices of performance are available. These are achievement, consistency, and matching. Achievement is the extent to which a team successfully judged the criterion. It is measured by the correlation between the team responses (Y_s) and the criterion (Y_e). Consistency is the extent to which a team uses cues in some systematic fashion. It is measured by the correlation between the responses (Y_s) and the predicted responses (Y'_s) of the team. Matching is the degree to which the equation used to predict team responses matches the optimal equation. It reflects the extent to which the team uses (weights) the cues (Y'_s) in the same manner as in the optimal equation (Y'_e). The four indices are related, given Equations 1 and 2, as shown in Equation 7.

$$r_a = R_e R_s r_m \quad [7]$$

Stimuli

Three sets of cues and criteria were generated by the Dickinson and Wherry (1973) computer program. Each set consisted of four cues, two cue crossproducts and a criterion. The set characterized by complexity had cues correlated with the criterion but the cues were not intercorrelated. Two unique pairs of cues (numbers 1 and 4, 2 and 3) in the redundancy set were intercorrelated and all four cues were correlated with the criterion. The third set, characterized by organization, had cues which were not correlated with the criterion, but the two cue crossproducts (numbers 1 and 4, 2 and 3) were correlated with the criterion. The theoretical and empirical correlations among the cues and criterion for each set are displayed in Table 1. The cues, crossproducts, and criterion for each set are included in Appendix A.

Table 1

Factor Structures, Empirical Correlations, and Theoretical Correlations of Task Structures[1]

Tasks Characterized by Redundancy, $\underline{R}^2$ = .9992

#	Factor Structure					Variable Correlations[2]						
	I	II	III	IV	U[3]	1	2	3	4	5	6	7
1	947	000	000	264	183		000	000	500	000	000	581
2	000	947	264	000	183	102		500	000	000	000	581
3	000	264	947	000	183	-012	506		000	000	000	581
4	264	000	000	947	183	469	-021	003		000	000	581
5[4]						068	036	073	007		000	000
6[5]						-023	003	-072	105	-063		000
7[6]	480	480	480	480	280	622	582	511	597	113	070	

Tasks Characterized by Complexity, $\underline{R}^2$ = .9992

#	I	II	III	IV	U	1	2	3	4	5	6	7
1	975	000	000	000	222		000	000	000	000	000	474
2	000	975	000	000	222	015		000	000	000	000	474
3	000	000	975	000	222	000	017		000	000	000	474
4	000	000	000	975	222	-098	-090	024		000	000	474
5[4]						-030	-025	053	063		000	000
6[5]						-064	000	-036	113	-019		000
7[6]	486	486	486	486	234	423	473	390	470	052	053	

Table 1 (continued).

Tasks Characterized by Organization, $\underline{R}^2 = .9995$

#	Factor Structure					Variable Correlations[2]						
	I	II	III	IV	U[3]	1	2	3	4	5	6	7
1	975	030	000	000	202		000	000	000	000	000	000
2	030	975	030	000	202	-035		000	000	000	000	000
3	000	030	975	030	202	-012	001		000	000	000	000
4	000	000	030	975	202	003	060	-080		000	000	000
5[4]						180	124	034	-053		000	671
6[5]						032	-147	059	005	093		671
7[7]						130	-035	069	-008	663	706	

[1]Decimals omitted.
[2]Empirical values below diagonal and theoretical values above.
[3]Uniqueness.
[4]Product of variables 1 & 4.
[5]Product of variables 2 & 3.
[6]Criterion.
[7]Criterion obtained as the linear combination of variables 1-6, weighted .0, .0, .0, .0, .67, & .67, respectively.

Design

The basic design was a 3x2x2x4 repeated measures factorial with three task structures (characterized by redundancy, complexity, or organization), two task component distributions (two-component or three-component), two work interactions (unrestricted or restricted), and four blocks of twenty-five trials.

Procedure

Ss were arranged in teams of three and each was given 100 cards in a box with the appropriate cues and criteria printed on them (Dickinson, 1969a). In all conditions Ss were instructed that each of them was to make and record a prediction on the basis of their own cues. Then they could interact with the other team member(s) to determine the team prediction based on the individual predictions. After recording the team prediction, the criterion value was observed by removing the card from the box. Instructions for each condition are presented in Appendix B.

The Ss in the two-component task distribution each observed a different pair of the four cues. That is, one team member received cues numbered 1 and 2; another member received cues numbered 2 and 3; and the last member received cues numbered 2 and 4. Each team member in the three-component task distribution observed three cues. One team member received cues numbered 1, 2, and 3; another member received cues numbered 1, 2, and 4; and the last member received cues numbered 2, 3, and 4.

In restricted work interaction, one member could communicate with both other team members while they could only communicate with her/him. This individual made and recorded the team response without the consensus of the other two members. In the unrestricted work interaction, team members could arrive at the team response however they wished.

Upon completion of the 100 trials, all Ss responded to a questionnaire (see Appendix C). Two of the questionnaire items were pertinent to this study; the remaining items were included for future research. The two items dealt with the cue and criterion relationship and whether the team had a leader (items 1 and 2, respectively). They were included to investigate Ss' perceptions of the task structure and work interaction treatments. After completing the questionnaire, Ss were debriefed and their questions were answered.

Results

Data Analysis

Multiple regression analyses, as in Equations 1 and 2, were computed for team responses and criterion values for each of the 120 teams. Once these equations were computed the four scores (Y_e, Y_s, Y'_e, Y'_s) were available for each team. These were used to obtain the three team performance indices (achievement, matching, and consistency) described in the previous section.

The multiple regression analyses were done in two ways. One procedure involved analyses for each of four blocks of twenty-five trials for each team. This yielded three performance indices for each of four blocks of trials. All of these correlations were transformed into Fisher's z values for use in 3x2x2x4 analyses of variance. Multiple regression analyses were also computed over all 100 trials. This yielded three performance indices which were transformed into Fisher's values for use in 3x2x2 analyses of variance.

The results are presented as they relate to the three hypotheses, followed by the findings of the achievement, matching, and consistency analyses, and finally the results of the questionnaire. When mentioning specific results, task structure is referred to as TS, tasks characterized by redundancy as RTS, tasks characterized by complexity as CTS, and tasks characterized by organization as OTS. In a similar fashion, task component distribution is referred to as TCD, three-components as 3TCD, two-components as 2TCD, work interaction as WI, unrestricted-interaction as UWI, and restricted-interaction as RWI.

Hypotheses

Hypothesis I

Hypothesis I predicts an interaction between task structure and task component distribution due to a positive slope of tasks characterized by organization from two- to three-components and zero slopes of the tasks characterized by redundancy and complexity.

Planned comparisons indicated no support ($p > .05$) for the hypothesis of an interaction between TS and TCD on the achievement and matching indices for blocks of trials (see Table 2). The first comparison was made on the 2TCD and 3TCD means of RTS weighted +1 and -1 and of CTS weighted +1 and -1 compared to those of OTS weighted -2 and +2. The second comparison was made on the 2TCD and 3TCD means of RTS weighted +1 and -1 to those of OTS weighted -1 and +1. The third comparison was made on the 2TCD and 3TCD means of CTS weighted +1 and -1 to those of OTS weighted -1 and +1.

The results of the achievement analysis for 100 trials were similar to those for blocks (see Table 2). The comparison of the TCD slopes of RTS and CTS to that of OTS indicated the three slopes were not different; nor were the slope comparisons of RTS to OTS and CTS to OTS. However, the results of the matching analysis indicated the TCD slopes of RTS and CTS were different from OTS (F=4.79, df=1,108, p<.05). Also, the slope of RTS was different from OTS (F=4.59, df=1,108, p<.05), whereas the slope of CTS was not (F=2.72, df=1,108, p<.11).

Table 2

Planned Comparisons under Hypothesis I for the Interaction of Task Structure and Task Component Distribution

TS x TCD Comparisons		Block Analysis				Overall Analysis			
		Achievement		Matching		Achievement		Matching	
	df	*MS*	*F*	*MS*	*F*	*MS*	*F*	*MS*	*F*
RTS, CTS vs. OTS x TCD	1	0.144	0.80	0.087	0.22	0.091	2.16	0.915	4.79*
RTS vs. OTS x TCD	1	0.131	0.73	0.288	0.73	0.079	1.88	0.877	4.59*
CTS vs. OTS x TCD	1	0.088	0.49	0.198	0.50	0.058	1.38	0.520	2.72
Error	108	0.180		0.395		0.042		0.191	

Note.--TS = task structure, TCD = task component distribution, RTS = redundancy task structure, CTS = complexity task structure, and OTS = organization task structure.

*p<.05.

Hypothesis II

Hypothesis II predicts an interaction between task structure and work interaction due to a positive slope of the tasks characterized by organization from restricted- to unrestricted-interaction and zero slopes of the tasks characterized by redundancy and complexity.

No support was obtained for the hypothesis of an interaction between TS and WI for blocks of trials (see Table 3). This was tested by three planned comparisons, which were all nonsignificant ($p>.05$). The first comparison was made on the UWI and RWI means of RTS weighted -1 and +1 and of CTS weighted -1 and +1 to those of OTS weighted +2 and -2. The second comparison was made on the UWI and RWI means of RTS weighted -1 and +1 to those of OTS weighted +1 and -1. The third comparison was made on the UWI and RWI means of CTS weighted -1 and +1 to those of OTS weighted +1 and -1.

The above results for blocks of trials were not contradicted by the results calculated for the 100 trials (see Table 3). The comparison of the WI slopes of OTS to those of RTS and CTS indicated the three slopes were not different; nor were the slope comparisons of RTS to OTS and CTS to OTS.

Hypothesis III

Hypothesis III predicts an interaction between task component distribution and work interaction due to a positive slope of two-component tasks from restricted- to unrestricted-

Table 3

Planned Comparisons under Hypothesis II for the Interaction of Task Structure and Work Interaction

TS x WI Comparisons		Block Analysis				Overall Analysis			
		Achievement		Matching		Achievement		Matching	
	df	*MS*	*F*	*MS*	*F*	*MS*	*F*	*MS*	*F*
RTS, CTS vs. OTS x WI	1	0.051	0.28	0.227	0.57	0.025	0.60	0.626	3.28
RTS vs. OTS x WI	1	0.009	0.05	0.086	0.22	0.005	0.12	0.357	1.87
CTS vs. OTS x WI	1	0.087	0.48	0.283	0.72	0.041	0.98	0.599	3.14
Error	108	0.180		0.395		0.042		0.191	

Note.--TS = task structure, WI = work interaction, RTS = redundancy task structure, CTS = complexity task structure, OTS = organization task structure.

interaction and zero slope of the three-component tasks.

The results computed for blocks of trials did not indicate significant differences ($p > .05$) in team achievement or matching performance due to an interaction between TCD and WI. This was tested by a comparison of the RWI and UWI means of 3TCD weighted -1 and +1 to those of 2TCD weighted +1 and -1.

The results computed for all 100 trials were similarly non-significant (see Table 4).

Table 4

Planned Comparisons under Hypothesis III for the Interaction of Task Component Distribution and Work Interaction

TCD x WI Comparisons		Block Analysis				Overall Analysis			
		Achievement		Matching		Achievement		Matching	
	df	*MS*	*F*	*MS*	*F*	*MS*	*F*	*MS*	*F*
2TCD vs. 3TCD x WI	1	0.019	0.11	0.184	0.47	0.026	0.63	0.492	2.58
Error	108	0.180		0.395		0.042		0.191	

Note.--TCD = task component distribution, WI = work interaction, 3TCD = three-component task distribution, and 2TCD = two-component task distribution.

Performance Indices

Team Achievement

A summary of the 3x2x2x4 analysis of variance on the Fisher's z transformations of achievement is presented in Table 5. This table indicates a significant TS effect (F=183.01, df=2,108, p<.01). The average achievement correlation coefficients were .75 in RTS, .57 in CTS, and .08 in OTS. Analysis of these TS means using the Newman-Keuls procedure (Kirk, 1968) indicated greater achievement in RTS than CTS ($p<.01$) and OTS ($p<.01$) and greater achievement in CTS than OTS ($p<.01$). [Appendix D contains the highest-order interaction cell means of this and the subsequent five analyses of variance. The appropriate cell means can be averaged to obtain the means for any main effect or interaction.]

Newman-Keuls analysis indicated the significant Blocks effect ($F=31.44$, $df=3,324$, $p<.01$) was due to lower performance in the first block of twenty-five trials than in any of the following blocks ($p<.01$). All other differences between Blocks means were nonsignificant.

The TS by Blocks ($F=16.02$, $df=6,324$, $p<.01$) and TS by TCD by Blocks ($F=2.18$, $df=6,324$, $p<.05$) were the only significant interactions. Newman-Keuls analysis ($p<.05$) indicated the TS by Blocks interaction was due to increasing achievement from Block 1 through Block 3 in the RTS and CTS profiles, while that of OTS increased from Block 1 to 2 but decreased from Block 2 to 3. In addition, from Block 3 to 4 achievement increased in OTS, decreased in CTS, and remained the same in RTS.

Newman-Keuls analysis ($p<.05$) indicated the significant TS by TCD by Blocks interaction was due to fluctuating ($\bar{z}=-.14$ to $.32$), essentially random, performance in OTS, as

Table 5

Summary of the Analysis of Variance on Achievement over Blocks of Trials

Source of Variance	*df*	*MS*	*F*
Task Structure (TS)	2	32.942	183.01**
Task Component Distribution (TCD)	1	0.003	0.02
TS x TCD	2	0.298	1.66
Work Interaction (WI)	1	0.092	0.51
TS x WI	2	0.182	1.01
TCD x WI	1	0.162	0.90
TS x TCD x WI	2	0.112	0.62
Teams/TS x TCD x WI	108	0.180	
Blocks (B)	3	1.652	31.44**
TS x B	6	0.842	16.02**
TCD x B	3	0.072	1.36
WI x B	3	0.116	2.20
TS x TCD x B	6	0.115	2.18*
TS x WI x B	6	0.047	0.89
TCD x WI x B	3	0.054	1.03
TS x TCD x WI x B	6	0.045	0.85
Error	324	0.053	

*$p<.05$.
**$p<.01$.

well as, an intersection of the 3TCD and 2TCD profiles of CTS. In both the 2TCD and 3TCD profiles of OTS achievement increased from Block 1 to 2, decreased from Block 2 to 3, and increased from Block 3 to 4. This was contrasted by the 2TCD and 3TCD profiles of RTS; in both profiles achievement increased from Block 1 to 2, while Blocks 2, 3, and 4 remained the same. The 3TCD profile of CTS increased from Block 1 to 2 then was level across Blocks 2, 3, and 4; however, the 2TCD profile of CTS was level across all four Blocks.

Table 6 presents the summary of the 3x2x2 analysis of variance on the Fisher's z transformations of achievement over all 100 trials. Only TS is significant ($\underline{F}$=175.45, $\underline{df}$=2,108, $\underline{p}$<.01). The achievement correlation coefficients were .72 in RTS, .55 in CTS, and .06 in OTS. Newman-Keuls analysis indicated greater achievement occurred in RTS than CTS ($\underline{p}$<.01) and OTS ($\underline{p}$<.01) and greater achievement occurred in CTS than OTS ($\underline{p}$<.01).

Team Matching

A summary of the 3x2x2x4 analysis of variance on the Fisher's z transformations of matching is presented in Table 7. The results of the analysis on matching were quite similar to that on achievement, in that the TS and Blocks main effects, as well as, the TS by Blocks interaction were significant. A Newman-Keuls analysis indicated the TS effect ($\underline{F}$=175.44, $\underline{df}$=2,108, $\underline{p}$<.01) was due to greater matching in RTS than CTS

Table 6

Summary of the Analysis of Variance on Achievement over all Trials

Source of Variance	*df*	*MS*	*F*
Task Structure (TS)	2	7.428	175.45**
Task Component Distribution (TCD)	1	0.007	0.17
TS x TCD	2	0.047	1.10
Work Interaction (WI)	1	0.054	1.28
TS x WI	2	0.021	0.51
TCD x WI	1	0.012	0.30
TS x TCD x WI	2	0.028	0.66
Error	108	0.042	

**$p<.01$.

($p<.05$) and OTS ($p<.01$), and greater matching in CTS than OTS ($p<.01$). Average matching correlation coefficients were .91 in RTS, .81 in CTS, and .15 in OTS. Again, the Blocks effect ($F=20.03$, $df=3,324$, $p<.01$) was due to lower performance in the first block of twenty-five trials than in any of the following blocks ($p<.01$). All other differences between Blocks means were nonsignificant.

Newman-Keuls analysis ($p<.05$) indicated the TS by Blocks

Table 7

Summary of the Analysis of Variance on Matching over Blocks of Trials

Source of Variance	df	MS	F
Task Structure (TS)	2	77.197	195.44**
Task Component Distribution (TCD)	1	0.516	1.31
TS x TCD	2	0.659	1.67
Work Interaction (WI)	1	0.096	0.24
TS x WI	2	0.568	1.44
TCD x WI	1	0.904	2.29
TS x TCD x WI	2	0.348	0.88
Teams/TS x TCD x WI	108	0.395	
Blocks (B)	3	3.841	20.03**
TS x B	6	2.126	11.08**
TCD x B	3	0.240	1.25
WI x B	3	0.269	1.40
TS x TCD x B	6	0.166	0.87
TS x WI x B	6	0.120	0.63
TCD x WI x B	3	0.057	0.30
TS x TCD x WI x B	6	0.134	0.70
Error	324	0.192	

**$p<.01$.

interaction (F=11.08, df=6,324, p<.01) was again due to fluctuating ($\bar{z}$=-.16 to .55) essentially random, performance in OTS; as well as, differences in CTS and RTS profile slopes from Block 1 to 2 and from Block 3 to 4. The OTS profile increased from Block 1 to 2, decreased from Block 2 to 3, and increased from Block 3 to 4. In the CTS profile matching increased from Block 1 to 3, although 2 was not significantly different from either 1 or 2, and decreased from Block 3 to 4. RTS evidenced an increment from Block 1 to 2 but the profile was level thereafter. Thus, the form of the TS by Blocks interaction was similar to those of achievement and matching.

Table 8 presents the summary of the 3x2x2 analysis of variance on the Fisher's z transformations of matching over all 100 trials. Only TS is significant (F=168.26, df=2,108, p<.01). Average matching correlation coefficients were .96 in RTS, .91 in CTS, and .20 in OTS. Newman-Keuls analyses indicated greater matching occurred in RTS than CTS (p<.01) and OTS (p<.01) and greater matching occurred in CTS than OTS ($p \leq$.01).

Team Consistency

A summary of the 3x2x2x4 analysis of variance on the Fisher's z transformations of consistency is presented in Table 9. The results of the analysis on consistency were similar to those on achievement and matching in that the TS

Table 8

Summary of the Analysis of Variance on Matching over all Trials

Source of Variance	df	MS	F
Task Structure (TS)	2	32.072	168.26**
Task Component Distribution (TCD)	1	0.253	1.33
TS x TCD	2	0.478	2.51
Work Interaction (WI)	1	0.066	0.35
TS x WI	2	0.328	1.72
TCD x WI	1	0.491	2.58
TS x TCD x WI	2	0.379	1.99
Error	108	0.191	

$^{**}p<.01$.

and Blocks main effects, as well as, the TS by Blocks interaction were significant. A Newman-Keuls analysis indicated the TS effect (F=56.13, df=2,108, $p<.01$) was due to greater consistency in RTS than CTS ($p<.01$) and OTS ($p<.01$) and greater consistency in CTS than OTS ($p<.01$).

Again, Newman-Keuls analyses indicated the Blocks effect (F=40.51, df=3,324, $p<.01$) was due to lower performance in the first block of twenty-five trials than in any of the fol-

Table 9

Summary of the Analysis of Variance on Consistency over Blocks of Trials

Source of Variance	*df*	*MS*	*F*
Task Structure (TS)	2	14.370	56.13**
Task Component Distribution (TCD)	1	0.250	0.98
TS x TCD	2	0.277	1.08
Work Interaction (WI)	1	0.156	0.61
TS x WI	2	0.032	0.13
TCD x WI	1	0.017	0.07
TS x TCD x WI	2	0.119	0.46
Teams/TS x TCD x WI	108	0.256	
Blocks (B)	3	2.372	40.51**
TS x B	6	0.228	3.89**
TCD x B	3	0.116	1.99
WI x B	3	0.057	0.97
TS x TCD x B	6	0.140	2.39*
TS x WI x B	6	0.106	1.82
TCD x WI x B	3	0.018	0.31
TS x TCD x WI x B	6	0.132	2.26*
Error	324	0.059	

*$p < .05$.
**$p < .01$.

lowing blocks ($p<.01$). All other differences between Blocks means were nonsignificant.

As indicated by a Newman-Keuls analysis the significant TS by Blocks interaction ($F=3.89$, $df=6,324$, $p<.01$) was due to differences among slopes of the TS profiles from Block 1 to 2. In both the OTS and RTS profiles there was an increase in consistency from Block 1 to 2 ($p<.05$) with no change thereafter. In the CTS profile, Block 2 was not different from Block 1 or 3, but there was greater consistency in Block 3 than 1 ($p<.05$).

Neither Newman-Keuls analyses nor graphs of the profiles of the TS by TCD by Blocks interaction ($F=2.39$, $df=6,324$, $p<.05$) and the TS by TCD by WI by Blocks interaction ($F=2.69$, $df=6,324$, $p<.05$) led to coherent interpretations. For example, in the TS by TCD by Blocks interaction each TS had a cross-over between different blocks in its TCD-Block profiles. The situation was even worse in the TS by TCD by WI by Blocks interaction. In this interaction, the OTS profiles were essentially random (fluctuating around zero) and those of CTS and RTS had numerous cross-overs between blocks.

Table 10 presents the summary of the 3x2x2 analysis of variance on the Fisher's z transformations of consistency over all 100 trials. Only TS is significant ($F=68.76$, $df=2,108$, $p<.01$). Newman-Keuls analyses indicated greater consistency occurred in RTS than CTS ($p<.01$) and OTS ($p<.01$) and greater consistency occurred in CTS than OTS ($p<.01$).

It should be noted the same comparisons of slopes that were calculated on achievement and matching, over blocks and all trials, were also calculated on consistency. However, the results were not hypothesized and were nonsignificant ($p>.05$); therefore, they are not presented.

Table 10

Summary of the Analysis of Variance on Consistency over all Trials

Source of Variance	*df*	*MS*	*F*
Task Structure (TS)	2	4.386	68.76**
Task Component Distribution (TCD)	1	0.036	0.57
TS x TCD	2	0.043	0.67
Work Interaction (WI)	1	0.068	1.06
TS x WI	2	0.002	0.03
TCD x WI	1	0.050	0.78
TS x TCD x WI	2	0.017	0.26
Error	108	0.064	

**p<.01.

Summary of Performance Results

The hypotheses of interactions on team achievement and matching performance were not supported by analyses for blocks or over all trials, with the exception of weak support for the TS by TCD interaction on matching over all trials. The most apparent finding was the large differences in team achievement, matching, and consistency performance among task structures. The highest average performance was associated with RTS followed by that of CTS while the lowest performance was associated with OTS. The differences in performance whether calculated over blocks or all 100 trials were significant. The teams did appear to learn as indicated by the significant difference of achievement, matching, and consistency performance between the first block of trials and the subsequent three blocks. The interaction between TS and Blocks was significant for analyses on achievement, matching, and consistency. These interactions are of little interest, because they appear to be due mostly to random fluctuations in the OTS profiles.

The achievement and consistency analyses indicated an interaction of TS by TCD by Blocks. The final significant result of the analyses of variance on team performance indices was a TS by TCD by WI by Blocks interaction observed in the analysis on consistency. These three interactions are of little interest because they are due to minor changes in slopes between pairs of blocks.

Questionnaire

The frequency data from the first two questions were mixed case, with parameters estimated from the data (Sutcliffe, 1957). Thus only interactions involving the response, a random variable, were analyzed. Castellan (1965) presented a scheme for partitioning contingency tables which was used in the analyses on the responses to the first two questions.

Team member's responses to the first question asking about the relationship between the cues and criterion indicated only 21% (74/360) of the members were aware of the relationship. The chi-square analysis indicated that TS was not statistically independent of Relationship ($\underline{X}^2=66.58$, $\underline{df}=2$, $\underline{p}<.001$). This finding was due to a greater proportion of the RTS members recognizing the relationship than CTS (43% vs. 19%; $\underline{X}^2=20.00$, $\underline{df}=1$, $\underline{p}<.001$) and a greater proportion of RTS and CTS combined, recognizing the relationship than OTS (31% vs. 0%; $\underline{X}^2=46.58$, $\underline{df}=1$, $\underline{p}<.001$). These and other results of chi-square analyses on the responses to the question concerning the cue-criterion relationship are presented in Table 11, while the actual frequencies are presented in Appendix E.

The three-way interaction of TS, TCD, and Relationship was also significant ($\underline{X}^2=65.54$, $\underline{df}=2$, $\underline{p}<.001$). A greater proportion of RTS team members recognized the relationship in 2TCD (48%) versus 3TCD (37%); no differences in proportions between 2TCD and 3TCD were observed in CTS (17% vs. 22%) or in OTS (0% vs. 0%).

Table 11

Chi-square Analyses on the Team Member's Responses to the Question about the Cue and Criterion Relationship

Source	*df*	X^2
TS x Relationship	2	66.58****
(RTS vs. CTS) x Relationship	1	20.00****
[(RTS+CTS) vs. OTS] x Relationship	1	46.58****
TCD x Relationship	1	1.70
TS x TCD x Relationship	2	69.54****
[(RTS+CTS) vs. OTS] x (Relationship/3TCD)	1	19.46****
[(RTS+CTS) vs. OTS] x (Relationship/2TCD)	1	27.39****
WI x Relationship	1	0.61

Note.--TS = task structure, RTS = redundancy task structure, CTS = complexity task structure, OTS = organization task structure, TCD = task component distribution, /3TCD = within three-component task distribution, /2TCD = within two-component task distribution, and WI = work interaction

****p<.001.

Other significant interactions were TS by WI by Relationship and TS by TCD by Relationship. However, they were difficult to interpret because of the extremely small differences in proportions, and for this reason are not presented.

Table 12 presents the results of the analyses on the team members responses to the question, "Did your team have a leader?" Sixty percent of the team members indicated by their responses to the second question that their team had a leader. The actual frequencies of response are presented in Appendix E.

The analysis on the TS by Leader interaction indicated the variables are negatively associated ($\underline{X}^2=11.32$, $\underline{df}=2$, $\underline{p}<.005$). The proportion of members in RTS indicating their team had a leader was not different from those in CTS (58% vs. 51%; $\underline{X}^2=1.11$, $\underline{df}=1$, $\underline{p}>.25$); however, the proportion of those in RTS and CTS combined was less than those in OTS (54% vs. 72%; $\underline{X}^2=10.21$, $\underline{df}=1$, $\underline{p}<.005$).

TCD and Leader were not associated ($\underline{p}>.50$). However, the TS by TCD by Leader interaction was significant ($\underline{X}^2=18.06$, $\underline{df}=2$, $\underline{p}<.001$) This interaction was due to a greater proportion of OTS (78%) than RTS and CTS combined (53%) indicating a team leader within 2TCD ($\underline{X}^2=10.58$, $\underline{df}=1$, $\underline{p}<.005$), whereas the proportions were not different within 3TCD (65% vs. 55%; $\underline{X}^2=1.65$, $\underline{df}=1$, $\underline{p}<.25$).

Table 12

Chi Square Analyses on the Team Member's Responses to the Question of whether Their Team Had a Leader

Source	*df*	X^2
TS x Leader	2	11.32***
(RTS vs. CTS) x Leader	1	1.11
[(RTS+CTS) vs. OTS] x Leader	1	10.21***
TCD x Leader	1	0.42
TS x TCD x Leader	2	18.06***
[(RTS+CTS) vs. OTS] x (Leader/3TCD)	1	1.65
[(RTS+CTS) vs. OTS] x (Leader/2TCD)	1	10.58***
WI x Leader	1	135.00****

Note.--TS = task structure, RTS = redundancy task structure, CTS = complexity task structure, OTS = organization task structure, TCD = task component distribution, /3TCD = within three-component task distribution, /2TCD = within two-component task distribution, and WI = work interaction

***$p<.005$.

****$p<.001$.

WI was associated with Leader (X^2=135.00, *df*=1, $p<.001$) due to a greater proportion indicating a leader in RWI than UWI (90% vs. 30%). This greater proportion indicates that the experimental instructions were effective. That is, in RWI a leader was always present (designated by the *E*), whereas in the UWI a leader may or may not have been present (emerging over trials).

Other significant interactions were TS by WI by Leader, TCD by WI by Leader, and TS by TCD by WI by Leader. These interactions were difficult to interpret because of the extremely small differences in proportions, and for this reason are not presented.

Discussion

The first hypothesis of positive slope from two- to three-components for tasks characterized by organization was supported by comparisons of redundancy and complexity to organization, as well as, redundancy to organization in the analysis of matching over all trials. However, all other comparisons were nonsignificant. This weak support for the task structure and task component distribution interaction is in contrast to the strong effect observed on achievement and matching by Dickinson (1969b). He found that team performance was differentially influenced by task component distributions, in tasks characterized by organization and complexity. Performance increased from one-component, to partial-two-components, to three-components in tasks characterized by organization, while in tasks characterized by complexity, performance was unaffected by task component distribution. The contradictory results of Dickinson (1969b) and the present study may be due to the different performance levels between studies in tasks characterized by organization. His average achievement and matching correlation coefficients were .72 and .94, as compared to .08 and .15 in the present study. Thus, the limited support for the prediction of an organization positive slope appears due to the failure of teams to recognize the cue-criterion relationship.

Because the near zero performance in tasks characterized by organization may have obscured the results, post hoc analyses were computed to further evaluate Hypothesis I. It was evaluated by testing the predicted zero slopes of redundancy and complexity from two- to three-component task distributions. Each pair of t ratios for blocks of trials and over all trials analyses on achievement and matching were nonsignificant. This supported the model's prediction of zero slopes in tasks characterized by redundancy and complexity. Therefore, the possibility remains that task structure interacts with task component distribution to influence team performance.

The teams' failure to perceive the cue-criterion relationship also obliterated the possibility of obtaining results supporting the second hypothesis of a positive slope from unrestricted- to restricted-work interaction in tasks characterized by organization. Although this hypothesis was derived from the Dickinson-Naylor model, the only other test of it did not indicate support for the prediction (Dickinson, 1969a). As mentioned in the introduction, this may have been due to the fact that his teams were composed of only two members; whereas, work interaction would seem to be a more important determinant of performance in larger teams. It was pointed out in the literature review that dyads are uniquely different from larger groups and that two-member are probably different from three-member teams. However, it can not be determined from the present study whether the slope of organization should be positive or negative.

Hypothesis II was evaluated post hoc by testing the predicted zero slopes of redundancy and complexity task structures from unrestricted- to restricted-work interaction. None of the four pairs of slopes were different from zero ($p > .05$) in the four analyses for blocks of trials and over all trials on achievement and matching. Failure to reject the null hypothesis implies support for the prediction of zero slopes of redundancy and complexity task structures. Therefore, the possibility remains that task structure interacts with work interaction to influence team performance.

No support for an interaction between task component distribution and work interaction (Hypothesis III) on team performance was found in this or previous studies, e.g., Dickinson (1969a). Dickinson (1969a) found that work interaction influenced members' responses; however, his treatments which led to the statistical interaction were different. The treatments which are comparable to the present study evidenced zero slopes.

Hypothesis III was investigated post hoc by testing the expected zero slope of two-components tasks to the predicted zero slope of three-components tasks from restricted- to unrestricted-work interaction. Although Hypothesis III predicts a positive slope for two-component tasks from restricted- to unrestricted-work interaction, the prediction was based on the expectation that performance in the restricted-work interaction, two-component task characterized by organization would be so low that it would depress the performance averaged across task structures. Low performance in the restricted-work interaction, two-component tasks would yield a significant interaction between task component distribution and work interaction. However, when only redundancy and complexity task structures are considered, the slopes of two- and three-component tasks from restricted- to unrestricted-work interaction are expected to be zero. Thus, $\underline{t}$ ratios were calculated to test the work interaction slopes of both two- and three-component tasks of achievement and matching for blocks of trials and over all trials analyses. All eight tests were nonsignificant. Again, failure to reject the null hypothesis implies support for the model's prediction of zero slopes of task component distributions when tasks characterized by organization are ignored. Therefore, the possibility remains that task component distribution interacts with work interaction to influence team performance.

In sum, the lack of significant interactions under the Hypotheses is tempered by the low level of performance in tasks characterized by organization. While the results may not be considered as supportive of the Dickinson-Naylor model of team performance, they also can not be considered as disconfirming it. Since the model's predictions of interactions depend largely on tasks characterized by organization, the present study does not provide adequate tests of the predictions due to the lack of team performance in the organization task structure. However, post hoc evaluation of the hypotheses indicated that the hypotheses may be veridical.

As described in the literature review, previous research (eg., Bales & Borgatta, 1955; and O'Dell, 1968) indicates that dyads are uniquely different from triads and larger groups in their pattern of interaction. Thus, it was concluded that the lack of influence observed for work interaction by Dickinson (1969a) was due to his use of dyads. Since Dickinson (1969a, 1969b) found that two-member teams could perform in tasks characterized by organization, it was thought that triads could also perform effectively im similar tasks. Apparently, the pattern of member interaction in triads interferes with or adds to the information processing of teams in tasks with component organization. Obviously, future research needs to investigate how the pattern of interaction hinders use of task organization.

The most influential variable affecting team performance was task structure, because all three team performance measures were related to it. The tasks characterized by organization were very difficult as evidenced by near zero achievement and matching. Moreover, the relationship between the cues and criterion was never recognized by the team members in tasks characterized by organization. Team performance was strongly related to the probability that team members recognized the cue-criterion relationship, because both performance and relationship recognition increased from organization to complexity and from complexity to redundancy task structures.

The blocks variable was also statistically significant for the three team performance indices. Performance increased from the first block to the second or third and was level thereafter. This was interpreted as a learning affect and has beeen observed in most research on the multiple-cue task, e.g., Naylor and Dickinson (1969), and Dickinson (1969a, 1969b). Blocks also interacted with task structure. The significant interaction on the three team performance indices was due to the fluctuating performance in the depressed organization profile, while the higher consistency and even more elevated redundancy profiles increased from the first block to later blocks of trials.

The significant task structure by task component distribution by blocks interactions on team achievement and matching were due to the cross-overs between different blocks of the task component distribution profiles within the three task structures. These two interactions and the task structure by task component distribution by work interaction by block interaction on consistency were considered to be of little interest as they appeared due to the near zero, fluctuating performance in the tasks characterized by organization.

Only 21% of all team members recognized the cue-criterion relationship. The proportion perceiving the relationship was significantly greater in tasks characterized by redundancy than those of complexity and significantly less than both in tasks characterized by organization. This finding corresponds highly to the performance results. Also, a greater proportion recognized the relationship in the two- than three-component task distribution of redundancy; whereas, the task component distributions did not differ for the complexity and organization task structures. It was expected that the relationship would be more obvious to team members in tasks characterized by redundancy, but the difference in the task distributions of redundancy was unexpected. It appears that the two-components are less distracting from the relationship than three-components when there is a strong relationship. Some substantiation for this notion is offered by the greater proportion of team members perceiving the relationship in two- than three-components of complexity.

In contrast to the relationship data, the proportion of team members indicating their team had a leader was greater in organization than redundancy and complexity combined. The proportion with a leader was greater in organization than redundancy and complexity combined within two-components task distribution, but the proportions were not different within three-components. Also, a greater proportion indicated a leader in restricted- than unrestricted-work interaction which implies the work interaction experimental instructions were effective. In sum, the questionnaire data confirmed several aspects of the performance analyses.

In conclusion the purpose of this research, to evaluate the influence of the interactions of task structure, task component distribution, and work interaction on team performance was not attained; but it appears that the interactions are predictive of team performance as team size and the number of components (predictors) increase in the multiple-cue task. Moreover, there were some findings while not formally hypothesized which aided in the interpretation of the performance data. Work interaction influenced team members' perceptions of whether their team had a leader. Also, the cue-criterion relationship was more likely to be recognized when the tasks were structured by redundancy, which was intended to be the most apparent relationship.

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Appendix A

Cues, Crossproducts, and Criterion of Redundancy, Complexity, and Organization Task Structures

Task Structure Characterized by Redundancy

Trial	Cues (Xs) 1	2	3	4	Crossproducts 14	23	Criterion (y)
001	57	43	35	59	57	60	52
002	42	51	62	37	60	51	45
003	51	58	69	55	51	65	67
004	68	59	46	52	54	47	58
005	53	42	45	49	50	54	43
006	46	47	46	46	52	51	48
007	47	40	45	41	53	55	35
008	67	37	46	56	59	55	57
009	61	48	52	61	62	50	61
010	42	44	55	39	60	47	41
011	42	60	60	62	40	60	65
012	43	71	72	48	52	95	58
013	45	67	58	32	58	63	50
014	52	50	58	50	50	50	55
015	65	41	26	70	80	71	56
016	41	49	60	57	44	49	52
017	60	48	56	54	54	49	55
018	37	47	33	43	59	56	37
019	39	42	43	35	67	55	34
020	41	49	43	40	59	51	41
021	59	48	44	71	68	51	64
022	45	53	40	42	54	47	38
023	29	49	50	45	60	50	39
024	34	44	38	62	31	57	39
025	49	45	58	53	50	46	51
026	57	49	54	55	54	49	52
027	50	57	43	44	50	45	46
028	40	57	50	35	64	50	39
029	41	64	54	54	46	56	56
030	36	53	58	45	58	52	41
031	49	54	47	44	51	49	45
032	60	64	60	62	62	64	67
033	56	46	58	44	47	47	50
034	45	52	40	41	55	48	39
035	48	37	53	48	50	47	43
036	76	69	57	54	60	64	72
037	53	53	58	55	52	52	61
038	50	70	65	54	50	79	69
039	54	43	43	57	53	54	49
040	57	37	39	39	43	63	42
041	33	54	53	45	59	51	37
042	48	47	51	48	50	50	42
043	44	40	46	43	54	54	41

Task Structure Characterized by Redundancy							
Trial	Cues (Xs)				Crossproducts		Criterion
	1	2	3	4	14	23	(y)
044	62	67	58	48	48	63	59
045	29	61	72	42	67	74	50
046	61	67	62	69	70	70	67
047	46	47	58	54	48	47	53
048	43	43	36	49	51	60	43
049	70	39	50	62	74	50	59
050	61	50	50	62	63	50	61
051	43	62	49	26	67	49	48
052	41	38	45	39	60	57	36
053	48	45	61	41	52	44	46
054	63	54	46	54	56	48	54
055	38	50	58	36	67	50	44
056	61	55	60	47	47	55	59
057	55	60	74	63	56	75	71
058	46	52	42	50	50	49	50
059	51	44	42	59	51	55	47
060	42	63	54	52	49	55	56
061	68	38	56	73	91	43	63
062	55	53	54	72	60	51	62
063	40	30	26	52	48	98	29
064	45	40	49	61	45	51	50
065	38	37	32	57	42	73	37
066	65	63	59	58	62	62	64
067	47	63	55	53	49	56	60
068	56	41	38	62	58	61	52
069	58	29	38	51	51	74	44
070	47	48	47	62	47	51	51
071	50	52	48	67	49	50	58
072	41	52	43	46	54	48	46
073	36	40	40	39	66	59	30
074	41	43	62	58	43	42	55
075	43	57	59	32	63	57	51
076	46	45	23	40	54	64	29
077	52	39	53	60	52	47	42
078	48	24	33	48	50	93	44
079	64	59	58	50	51	58	60
080	75	51	42	39	24	49	52
081	47	59	33	35	55	34	42
082	59	55	48	46	47	49	50
083	58	42	48	45	46	52	53
084	51	44	53	47	50	48	46
085	57	43	35	54	53	61	47
086	54	36	58	52	51	39	44

Trial	Cues (Xs) 1	2	3	4	Crossproducts 14	23	Criterion (y)
Task Structure Characterized by Redundancy							
087	49	54	49	47	50	50	47
088	35	36	55	43	61	43	37
089	42	58	49	51	49	49	50
090	60	70	49	63	63	48	72
091	44	52	55	43	55	51	42
092	50	31	40	49	50	69	37
093	34	49	62	30	82	49	44
094	47	52	50	46	51	50	51
095	60	70	58	47	47	65	65
096	64	59	43	68	75	43	63
097	52	52	53	46	49	50	45
098	45	49	61	35	57	49	45
099	60	49	51	53	53	50	53
100	48	61	51	42	51	51	52
Task Structure Characterized by Complexity							
001	55	47	34	58	54	56	52
002	46	47	62	38	55	47	45
003	50	52	68	55	50	54	67
004	70	60	44	47	43	43	59
005	55	43	48	48	49	52	43
006	47	47	46	45	52	51	48
007	50	41	47	40	50	52	35
008	68	37	50	51	51	51	56
009	59	47	52	60	59	49	60
010	44	43	58	39	56	44	41
011	36	59	58	65	29	57	64
012	43	66	68	49	51	79	59
013	50	68	55	31	50	59	50
014	52	47	59	50	50	47	55
015	61	47	25	67	68	56	55
016	39	46	61	61	38	45	52
017	59	46	58	52	52	47	55
018	38	51	31	46	54	48	37
019	42	43	45	37	60	54	34
020	44	51	44	43	54	49	40
021	54	49	43	70	58	50	63
022	47	57	39	42	52	42	38
023	28	51	50	52	47	50	39
024	29	46	39	68	12	54	40
025	49	43	60	53	50	43	51
026	57	48	55	54	53	49	53

Task Structure Characterized by Complexity

Trial	Cues (Xs) 1	2	3	4	Crossproducts 14	23	Criterion (y)
027	52	60	40	43	49	40	46
028	44	59	49	38	58	49	39
029	38	65	52	56	42	52	56
030	36	51	58	49	51	50	41
031	51	56	46	43	49	48	45
032	57	62	57	61	58	58	68
033	58	44	61	42	43	43	51
034	47	55	39	41	53	45	40
035	48	33	56	48	50	40	44
036	77	68	53	46	39	55	72
037	52	51	58	55	51	51	60
038	49	67	60	53	50	68	69
039	52	45	45	57	51	53	49
040	60	39	41	35	36	60	42
041	33	54	53	50	49	51	37
042	48	47	51	49	50	50	43
043	45	39	48	44	53	53	41
044	64	67	55	45	43	59	60
045	30	56	72	49	53	64	49
046	57	65	59	68	62	64	68
047	44	42	60	56	47	42	53
048	43	45	35	51	49	57	43
049	70	36	52	57	64	47	59
050	59	50	50	60	59	50	61
051	49	63	45	25	53	43	47
052	43	39	47	42	56	54	35
053	50	42	64	41	50	38	46
054	63	57	45	50	51	47	55
055	41	48	60	39	60	48	43
056	63	52	59	43	42	52	59
057	52	54	74	64	53	59	70
058	45	54	41	51	49	47	49
059	48	45	43	60	48	54	47
060	41	63	50	54	46	50	55
061	63	35	60	70	77	35	63
062	49	52	53	73	49	51	63
063	39	35	29	56	44	81	29
064	41	40	52	64	38	48	50
065	33	42	35	61	32	62	37
066	64	62	56	54	56	57	65
067	45	62	51	53	48	51	60
068	52	43	38	61	53	59	52
069	58	30	42	49	49	65	44

Trial	Cues (Xs) 1	2	3	4	Crossproducts 14	23	Criterion (y)
Task Structure Characterized by Complexity							
070	43	48	48	64	40	51	51
071	45	52	47	68	40	49	58
072	41	55	42	47	52	46	46
073	37	44	42	42	61	55	30
074	38	38	64	61	37	32	55
075	47	54	58	32	55	54	50
076	49	53	23	40	51	43	29
077	50	38	57	60	50	41	44
078	48	25	38	48	50	79	43
079	65	58	56	46	44	55	60
080	81	54	40	32	-7	46	52
081	49	65	28	33	51	16	42
082	62	57	47	43	42	48	50
083	60	40	50	42	41	50	52
084	52	43	55	46	49	47	47
085	57	46	36	53	52	55	47
086	55	32	63	52	51	27	45
087	50	55	49	48	50	49	47
088	36	33	60	48	53	33	37
089	41	59	45	53	48	45	51
090	57	73	42	60	57	32	71
091	50	51	56	44	50	50	43
092	62	33	46	49	49	57	37
093	59	44	63	34	35	42	43
094	50	52	49	46	50	50	51
095	38	69	53	43	58	56	65
096	46	64	39	67	43	35	63
097	48	52	53	45	51	50	46
098	59	47	62	35	36	46	45
099	54	47	52	50	50	50	54
100	47	63	48	40	53	47	51
Task Structure Characterized by Organization							
001	41	57	36	64	38	41	27
002	43	52	55	40	57	51	51
003	42	58	58	44	55	56	57
004	39	51	54	72	26	51	35
005	55	48	69	46	48	47	53
006	59	47	38	69	68	54	71
007	43	38	49	30	63	51	56
008	32	59	45	36	76	46	64
009	58	37	33	60	58	72	70

Task Structure Characterized by Organization

Trial	Cues (Xs) 1	2	3	4	Crossproducts 14	23	Criterion (y)
010	44	58	50	50	50	50	55
011	29	55	46	66	17	48	30
012	29	64	60	50	50	63	67
013	52	31	63	47	49	25	36
014	53	35	57	30	43	40	32
015	64	65	51	42	38	51	41
016	45	66	46	39	56	43	40
017	64	65	44	54	56	42	50
018	32	50	55	47	56	50	62
019	41	53	67	73	28	55	36
020	59	49	66	42	43	49	41
021	18	46	58	53	40	47	39
022	56	36	40	51	50	64	61
023	58	55	53	60	58	51	55
024	47	44	51	57	48	50	55
025	52	43	39	59	52	58	58
026	53	48	66	55	51	46	40
027	47	58	38	53	49	40	44
028	50	56	50	60	50	50	47
029	67	65	71	59	65	82	80
030	52	50	50	54	51	50	55
031	55	53	50	51	50	50	41
032	61	43	38	46	45	58	53
033	68	48	41	40	33	51	36
034	50	34	44	39	50	60	57
035	49	54	34	59	49	44	41
036	43	40	64	50	50	36	40
037	38	39	40	50	50	61	56
038	47	45	45	54	49	53	46
039	59	50	62	43	44	49	45
040	45	58	51	48	51	51	53
041	54	49	37	42	46	51	47
042	48	61	68	57	48	69	72
043	55	43	54	53	52	47	40
044	49	53	51	43	50	50	48
045	60	38	58	58	57	40	46
046	30	56	50	39	72	50	66
047	58	42	47	44	45	53	49
048	50	38	59	60	50	40	45
049	33	32	59	67	22	34	20
050	30	44	50	51	48	50	50
051	54	65	50	50	50	50	47
052	41	46	25	53	47	59	46

Task Structure Characterized by Organization

Trial	Cues (Xs) 1	2	3	4	Crossproducts 14	23	Criterion (y)
053	51	36	49	45	50	51	55
054	55	60	44	50	50	44	45
055	46	27	40	51	49	72	66
056	47	65	52	64	46	53	51
057	46	49	47	65	45	50	47
058	62	35	42	50	49	62	63
059	38	63	69	43	59	74	74
060	55	36	67	43	47	27	37
061	42	59	51	44	54	51	51
062	43	34	35	60	43	75	63
063	48	51	54	59	48	50	56
064	58	52	54	29	32	51	43
065	42	45	60	49	51	45	49
066	59	53	58	52	52	52	49
067	58	54	67	45	46	57	50
068	52	75	30	52	50	-0	21
069	59	65	51	37	38	51	44
070	53	42	52	66	55	48	52
071	49	44	55	27	52	47	49
072	54	42	38	24	39	59	56
073	46	57	60	47	51	57	61
074	55	45	45	63	57	53	58
075	44	65	44	47	52	41	44
076	56	54	59	50	50	54	47
077	59	59	43	56	55	44	53
078	41	66	51	47	53	51	51
079	53	71	36	57	52	20	25
080	42	54	41	50	50	46	53
081	42	35	47	46	53	54	60
082	71	34	48	41	30	53	41
083	50	47	42	58	50	52	47
084	44	44	52	47	52	49	45
085	48	46	41	43	51	54	51
086	53	49	38	59	52	52	52
087	60	35	61	53	53	34	36
088	55	53	34	39	44	45	49
089	52	57	56	48	50	55	42
090	65	57	47	57	61	48	59
091	56	47	47	46	47	51	52
092	51	53	47	42	50	49	44
093	56	57	53	48	49	52	52
094	61	54	61	54	55	54	55
095	43	50	65	31	64	50	60

Task Structure Characterized by Organization

Trial	Cues (Xs) 1	2	3	4	Crossproducts 14	23	Criterion (y)
096	65	45	47	60	65	52	65
097	45	48	43	37	57	51	48
098	45	43	57	37	57	45	51
099	79	55	54	66	98	52	90
100	40	60	33	59	41	33	34

Appendix B

Experimental Instructions

(Presented only for the tasks characterized by complexity and redundancy)

This experiment is part of a large project being conducted to determine people's ability to make predictions. In particular, the purpose of this experiment is to compare a person's ability to perform a prediction task to his ability to work in a team and cooperate with other persons. As an example of the kind of prediction-making of interest to us, consider the job of a weatherman. He gathers bits and pieces of information daily and looks at them in such a way as to arrive at a prediction of tomorrow's weather. This information may be regarded as one or more "cues". For example, air pressure, temperature, and humidity are three cues a weatherman uses in predicting future weather conditions.

Your task in this experiment will not be as complex as a weatherman's. Our "cues" will be four, 2-digit, whole numbers, and the team will use these numbers to predict a fifth, 2-digit, whole number, which we shall call the "criterion". Thus, one of your tasks will be to observe your number cues and to use them to predict the criterion. There will be 100 such prediction trials. Obviously, in the very beginning your predictions will be guesses, but as you proceed, you should become more accurate and adept.

Just as in the case of the weatherman, the interrelationships among your cues have to be considered in making predictions. For example, the weatherman has to consider the interrelationships among temperature, air pressure, and humidity. He knows that the usefulness of air pressure as a predictor of rain depends on the appropriate temperature and humidity conditions. When air pressure is low and temperature is low but humidity is high, rain is predicted. However, when air pressure is high rain is not predicted, regardless of the temperature level, unless humidity is extremely high.

In the same way, your number cues are appropriate predictors of the criterion only when considered in relation to each other. However, we have not entirely specified the interrelationships. Your prediction task is to learn and to use the complete set of interrelationships. The team which can do this best will receive fifteen dollars, five dollars for each member. Write your name and address on your experimental credit card so your check can be mailed to you this summer upon determining which of the ten teams was most accurate.

(Presented only for the tasks characterized by organization)

This experiment is part of a large project being conducted to determine people's ability to make predictions. In particular, the purpose of this experiment is to compare a person's ability to perform a prediction task to his ability to work in a team and cooperate with other persons. As an example of the kind of prediction-making of interest to us, consider the job of a weatherman. He gathers bits and pieces of information daily and looks at them in such a way as to arrive at a prediction of tomorrow's weather. This information may be regarded as one or more "cues". For example, air pressure, temperature, and humidity are three cues a weatherman uses in predicting future weather conditions.

Your task in this experiment will not be as complex as a weatherman's. Our "cues" will be four, 2-digit, whole numbers, and the team will use these numbers to predict a fifth, 2-digit, whole number, which we shall call the "criterion". Thus, one of your tasks will be to observe your number cues and to use them to predict the criterion. There will be 100 such prediction trials. Obviously, in the very beginning your predictions will be guesses, but as you proceed, you should become more accurate and adept.

Just as in the case of the weatherman, the interrelationships among your cues have to be considered in making predictions. For example, the weatherman has to consider the interrelationships among temperature, air pressure, and humidity. He knows that the usefulness of air pressure as a predictor of rain depends on the appropriate temperature and humidity conditions. When air pressure is low and temperature is low but humidity is high, rain is predicted. However, when air pressure is high rain is not predicted, regardless of the temperature level, unless humidity is extremely high.

In the same way, your number cues are appropriate predictors of the criterion only when considered in relation to each other. The interrelationships between your cues is the same as that shown in Figure 1. As you can see, the criterion value to predict depends on the values of your cues. In Figure 1, we

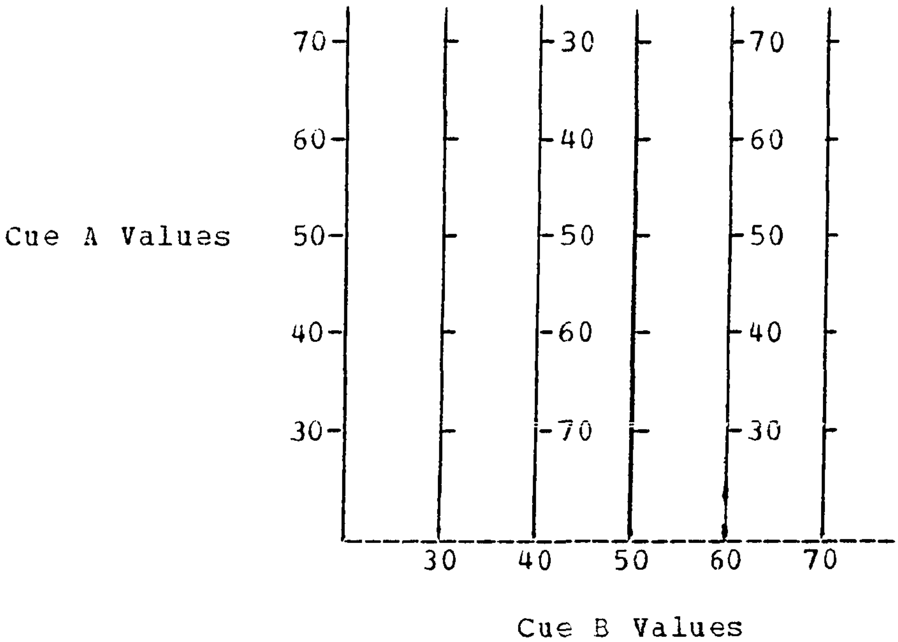

Fig. 1. Criterion values for various values of Cues A and B.

have chosen two values of B, 40 & 60, to illustrate part of the interrelationship. Thus, for Cue A equals 40 and Cue B equals 40, the value of the criterion to be predicted is 60. For Cue A equals 60 and Cue B equals 60, the value of the criterion to predict is 60. Finally for Cue A equals 30 and Cue B equals 60, the value of the criterion to predict is 30. The form of the interrelationships between your cues is the same as presented in Figure 1. However, we have not entirely specified the interrelationships. Your prediction task is to learn and to use the complete set of interrelationships. The team which can do this best will receive fifteen dollars, five dollars for each member. Write your name and address on your experimental credit card so your check can be mailed to you this summer upon determining which of the ten teams was most accurate.

(Presented only to the three component unrestricted condition)

We have provided you with a set of 100 numbered cards. Your cues are printed in the top left corner of the cards. Each card is numbered in the top right corner, so that you may keep track of which cue trial you are on. Each of you will have three of the four cues for 100 trials, that is, one partner will have cues A, B, C; another partner cues A, B, and D; and the other partner cues B, C, and D. In this way each of you can become expert in the way three of the cues interrelate to predict the criterion number. The criterion number is located on the card under the sliding piece of wood so that after you have made a prediction and remove the IBM card you will see the actual value of the criterion.

You will observe the following procedure on each trial in making your predictions:

1. Each member of the team will use his cues to make his own individual prediction of the criterion number. This value is to be recorded by marking on your card.

2. After these individual predictions, team partners are to "get together", discuss and compare their separate individual predictions, and then make a joint or team prediction. This value is to be recorded by all members below their individual prediction.

3. Following the recording of the team prediction, each team member removes the IBM card and looks at the actual value of the criterion number.

4. Place the IBM card face down, to the side, and for the next trial proceed with steps 1-3 again. As you proceed with the cue trials, do not look at the previous IBM cards.

Raise your hand if you have a question at any time.

(Presented only to the three component restricted condition)

We have provided you with a set of 100 numbered cards. Your cues are printed in the top left corner of the cards. Each card is numbered in the top right corner, so that you may keep track of which cue trial you are on. Each of you will have three of the four cues for 100 trials, that is, one partner will have cues A, B, C; another partner cues A, B, and D; and the other partner cues B, C, and D. In this way each of you can become expert in the way three of the cues interrelate to predict the criterion number. The criterion number is located on the leader's (person sitting at the end of the table) card under the sliding piece of wood. After you have made a prediction and remove the IBM card the leader will see the actual value of the criterion and read it aloud.

You will observe the following procedure on each trial in making your predictions:

1. Each member of the team including the leader will use his cues to make his own individual prediction of the criterion number. This value is to be recorded by marking on your card.

2. After these individual predictions, the leader is given his followers' predictions and uses these predictions, with his own to make a team prediction. This value is recorded by the leader below his own prediction.

3. Following the recording of the team prediction, each team member removes his IBM card and the team leader reads the actual value of the criterion number.

4. Place the IBM card face down, to the side, and for the next trial proceed with steps 1-3 again. As you proceed with the cue trials, do not look at the previous IBM cards.

Raise your hand if you have a question at any time.

(Presented only to the two component unrestricted condition)

We have provided you with a set of 100 numbered cards. Your cues are printed in the top left corner of the cards. Each card is numbered in the top right corner, so that you may keep track of which cue trial you are on. Each of you will have two of the four cues for 100 trials, i.e., one partner will have Cues A and B, another Cues B and D, and the other Cues C and D. In this way, one of you can become "expert" in the way Cue A interrelates with Cue B to predict the criterion number and the other team members "expert" in the way the other pairs of cues predict the criterion number. The criterion number is located on the card under the sliding piece of wood so that after you have made a prediction and remove the IBM card you will see the actual value of the criterion.

You will observe the following procedure on each trial in making your predictions:

1. Each member of the team will use his cues to make his own individual prediction of the criterion number. This value is to be recorded by marking on your card.

2. After these individual predictions, team partners are to "get together", discuss and compare their separate individual predictions, and then make a joint or team prediction. This value is to be recorded by all members below their individual prediction.

3. Following the recording of the team prediction, each team member removes the IBM card and looks at the actual value of the criterion number.

4. Place the IBM card face down, to the side, and for the next trial proceed with steps 1-3 again. As you proceed with the cue trials, do not look at the previous IBM cards.

Raise your hand if you have a question at any time.

(Presented only to the two component restricted condition)

We have provided you with a set of 100 numbered cards. Your cues are printed in the top left corner of the cards. Each card is numbered in the top right corner, so that you may keep track of which cue trial you are on. Each of you will have two of the four cues for 100 trials, i.e., one partner will have Cues A and B, another Cues B and D, and the other Cues C and D. In this way, one of you can become "expert" in the way Cue A interrelates with Cue B to predict the criterion number and the other team members "expert" in the way the other pairs of cues predict the criterion number. The criterion number is located on the leader's (person sitting at the end of the table) card under the sliding piece of wood. After you have made a prediction and remove the IBM card the leader will see the actual value of the criterion and read it aloud.

You will observe the following procedure on each trial in making your predictions:

1. Each member of the team including the leader will use his cues to make his own individual prediction of the criterion number. This value is to be recorded by marking on your card.

2. After these individual predictions, the leader is given his followers' predictions and uses these predictions, with his own to make a team prediction. This value is recorded by the leader below his own prediction.

3. Following the recording of the team prediction, each team member removes his IBM card and the team leader reads the actual value of the criterion number.

4. Place the IBM card face down, to the side, and for the next trial proceed with steps 1-3 again. As you proceed with the cue trials, do not look at the previous IBM cards.

Raise your hand if you have a question at any time.

Appendix C

Questionnaire

CIRCLE YOUR ANSWER TO THE THREE QUESTIONS BELOW

1. Can you describe the relationship between your cues and the criterion?

   A. as the cues increased in value, the criterion increased.

   B. as the cues decreased in value, the criterion increased.

   C. no relationship between the cues and the criterion.

   D. other, specify:

2. Did your team have a leader?

   A. yes.

   B. no.

3. If your team had a leader, where did he/she sit?

   A. across from me.

   B. in my chair.

   C. at the end of the table.

   D. to my left.

   E. to my right.

PLEASE ANSWER BY MARKING AN X IN THE APPROPRIATE INTERVAL BELOW

4. How much did you enjoy your task?

   Not at all:___:___:___:___:___:___:___:___:___:___:Very much
   1 2 3 4 5 6 7 8 9 10

5. How satisfied were you with the team's performance?

   Very dissatisfied:___:___:___:___:___:___:___:___:___:___:Very satisfied
   1 2 3 4 5 6 7 8 9 10

Appendix D

Highest Order Interaction Cell Means Corresponding to the Various Analyses of Variance

Table D-1

Task Structure x Task Component Distribution x Work Interaction x Block Interaction Cell Means from the Analysis on Achievement (as in Table 5)

Task Structure	Task Component Distribution	Work Interaction	Block 1	Block 2	Block 3	Block 4
Redundancy	3-Components	Unrestricted	0.62	1.11	1.00	0.96
Redundancy	3-Components	Restricted	0.84	0.95	1.07	1.06
Redundancy	2-Components	Unrestricted	0.65	1.12	1.18	1.03
Redundancy	2-Components	Restricted	0.81	1.18	1.19	0.93
Complexity	3-Components	Unrestricted	0.48	0.68	0.88	0.60
Complexity	3-Components	Restricted	0.44	0.74	0.74	0.54
Complexity	2-Components	Unrestricted	0.66	0.60	0.83	0.68
Complexity	2-Components	Restricted	0.72	0.61	0.78	0.47
Organization	3-Components	Unrestricted	-0.15	0.27	-0.17	0.23
Organization	3-Components	Restricted	0.06	0.38	0.07	0.40
Organization	2-Components	Unrestricted	-0.19	0.27	-0.06	0.14
Organization	2-Components	Restricted	-0.08	0.23	-0.19	0.15

Table D-2

Task Structure x Task Component Distribution x Work Interaction Interaction Cell Means from the Analysis on Achievement (as in Table 6)

Task Structure	Task Component Distribution: Three-Components UWI	Three-Components RWI	Two-Components UWI	Two-Components RWI
Redundancy	0.03	0.18	0.01	0.01
Complexity	0.86	0.92	0.90	0.94
Organization	0.62	0.59	0.61	0.63

Note.--UWI=unrestricted work interaction and RWI=restricted work interaction.

Table D-3

Task Structure x Task Component Distribution x Work Interaction x Block Interaction Cell Means from the Analysis on Matching (as in Table 7)

Task Structure	Task Component Distribution	Work Interaction	Block 1	2	3	4
Redundancy	3-Components	Unrestricted	1.04	1.84	1.52	1.40
Redundancy	3-Components	Restricted	1.37	1.52	1.70	1.53
Redundancy	2-Components	Unrestricted	1.15	1.67	1.75	1.58
Redundancy	2-Components	Restricted	1.18	1.62	1.74	1.46
Complexity	3-Components	Unrestricted	0.87	1.18	1.41	1.21
Complexity	3-Components	Restricted	0.90	1.25	1.14	1.07
Complexity	2-Components	Unrestricted	1.11	1.00	1.38	1.17
Complexity	2-Components	Restricted	1.15	0.98	1.27	0.87
Organization	3-Components	Unrestricted	-0.25	0.54	-0.33	0.41
Organization	3-Components	Restricted	0.18	0.79	0.10	0.66
Organization	2-Components	Unrestricted	-0.35	0.47	-0.08	0.24
Organization	2-Components	Restricted	-0.19	0.40	-0.33	0.24

Table D-4

Task Structure x Task Component Distribution x Work Interaction Interaction Cell Means from the Analysis on Matching (as in Table 8)

Task Structure	Task Component Distribution: Three-Components UWI	Three-Components RWI	Two-Components UWI	Two-Components RWI
Redundancy	1.77	1.96	2.06	1.84
Complexity	1.64	1.45	1.53	1.52
Organization	0.11	0.63	0.05	0.03

Note.--UWI=unrestricted work interaction and RWI=restricted work interaction.

Table D-5

Task Structure x Task Component Distribution x Work Interaction x Block Interaction Cell Means from the Analysis on Consistency (as in Table 9)

Task Structure	Task Component Distribution	Work Interaction	Block 1	Block 2	Block 3	Block 4
Redundancy	3-Components	Unrestricted	0.95	1.39	1.31	1.49
Redundancy	3-Components	Restricted	1.19	1.31	1.36	1.60
Redundancy	2-Components	Unrestricted	0.96	1.56	1.62	1.58
Redundancy	2-Components	Restricted	1.23	1.71	1.58	1.40
Complexity	3-Components	Unrestricted	0.89	0.94	1.17	1.18
Complexity	3-Components	Restricted	0.79	1.08	1.11	1.04
Complexity	2-Components	Unrestricted	0.96	0.96	1.14	0.99
Complexity	2-Components	Restricted	1.06	1.11	1.11	1.20
Organization	3-Components	Unrestricted	0.61	0.80	0.87	0.90
Organization	3-Components	Restricted	0.54	0.97	0.75	1.04
Organization	2-Components	Unrestricted	0.64	0.88	0.74	0.87
Organization	2-Components	Restricted	0.61	0.75	0.79	0.92

Table D-6

Task Structure x Task Component Distribution x Work Interaction Interaction Cell Means from the Analysis on Consistency (as in Table 10)

Task Structure	Task Component Distribution: Three-Components UWI	Three-Components RWI	Two-Components UWI	Two-Components RWI
Redundancy	1.01	1.06	1.13	1.16
Complexity	0.79	0.75	0.71	0.83
Organization	0.42	0.44	0.36	0.48

Note.--UWI=unrestricted work interaction and RWI=restricted work interaction.

Appendix E

Responses to Questions 1 and 2: Task Structure by Task Component Distribution by Work Interaction Cell Frequencies

Table E-1

Frequency of Team Members Describing the Relationship between Their Cues and Criterion (as in Table 11)

Variables		Work Interaction				
		Unrestricted		Restricted		Totals
Task Structure	Task Component Distribution	Yes	No	Yes	No	
Redundancy	3-Components	11	19	11	19	60
Redundancy	2-Components	12	18	17	13	60
Complexity	3-Components	4	26	6	24	60
Complexity	2-Components	7	23	6	24	60
Organization	3-Components	0	30	0	30	60
Organization	2-Components	0	30	0	30	60
Totals		54	126	162	18	360

Table E-2

Frequency of Team Members Responding They Had a Team Leader (as in Table 12)

Variables		Work Interaction				
		Unrestricted		Restricted		Totals
Task Structure	Task Component Distribution	Yes	No	Yes	No	
Redundancy	3-Components	12	18	27	3	60
Redundancy	2-Components	5	25	25	5	60
Complexity	3-Components	4	26	23	7	60
Complexity	2-Components	6	24	28	2	60
Organization	3-Components	10	20	29	1	60
Organization	2-Components	17	13	30	0	60
Totals		34	146	40	140	360